APPENDIX D

Background Information on OWTS

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BACKGROUND INFORMATION ON OWTS

This appendix provides additional information about various types of supplemental treatment units that are briefly discussed in Chapter 2 of the draft environmental impact report (DEIR).

D.1 AEROBIC TREATMENT UNITS

Aerobic treatment units (ATUs) are a broad category of preengineered wastewater treatment devices for residential and commercial use. They provide a se secondary level of treatment, which means they are designed to oxidize both organic material and ammonium-nitrogen (to nitrate-nitrogen), decrease suspended solids concentrations, and reduce concentrations of pathogens. ATUs may provide treatment using suspended-growth elements (activated sludge process), attached-growth elements (i.e., trickling biofilters), or in the case of hybrid aerobic systems, suspended-growth processes combined with attached-growth components (see below for a description of these processes).

Most ATUs do not sufficiently reduce pathogens. Additional disinfection can be achieved through chlorination, ultraviolet (UV) radiation, ozonation, and/or soil filtration. Increased nitrogen removal (denitrification) can be achieved by modifying the treatment process to incorporate an anaerobic/anoxic step or by adding the following treatments to the treatment train.

D.1.1 SUSPENDED-GROWTH AEROBIC TREATMENT UNITS

In a suspended-growth aerobic treatment unit, microorganisms maintained in suspension using aeration provide aerobic treatment of the wastewater. Such designs typically consist of aeration, clarification, and sludge return processes. Aeration generally requires an air pump to deliver oxygen to the unit as well as provide energy for mixing. Suspended-growth treatment units typically receive septic tank (primary treated) effluent, but some suspended-growth ATUs combine primary and secondary treatment processes, thereby eliminating the need for a separate septic tank ahead of the ATU. The principal types of processes are classified as continuous flow reactor, sequencing batch reactor, and membrane bioreactor.

D.1.2 ATTACHED-GROWTH AEROBIC TREATMENT UNITS (TRICKLING BIOFILTERS)

Treating wastewater by trickling it over a biofilter is among the oldest and most well-characterized technologies for aerobic treatment. These aerobic treatment systems for attached growth have also been described as intermittent (medium) filters, packed-bed filters, trickling filters, attached-growth processes, and fixed-film processes. The trickling biofilter system basically consists of a medium on which a microbial community (biofilm) develops, a container or lined excavated pit to house the medium, a system for applying the wastewater to be treated to the medium, and a system for collecting and distributing the treated wastewater. The wastewater to be treated is periodically applied, in small doses, to the medium. Trickling biofilters can be operated in single-pass or recirculating configurations. In a single-pass system, the wastewater to be treated is applied to the biofilter only once before being collected and conveyed to a subsequent treatment unit or dispersal system. In a recirculating system, a small volume of septic tank effluent and filtrate is dosed to the filter surface. Then a portion of the aerobic filtrate is recirculated back to a recirculation tank (or the septic tank). There, the aerobic filtrate mixes with anaerobic septic tank effluent, resulting in the removal of a significant amount of nitrogen.

D.1.3 HYBRID AEROBIC TREATMENT UNITS

Hybrid ATUs combine suspended- and attached-growth elements. They generally use an activated sludge process combined with either fixed internal packing or suspended internal packing as the attached-growth element. In general, the fixed-film component has a buffering effect in the event of a disturbance to the process, such as extreme hydraulic overloading, discharge of toxic compounds into the system, or a problem with aeration.

D.2 ANOXIC SYSTEMS

Anoxic treatment processes are characterized by the absence of free oxygen from the treatment process. Many aerobic treatment systems use anoxic or anaerobic stages to accomplish specific treatment objectives. Anoxic processes are typically used for the removal of nitrogen from wastewater through a process known as denitrification. Denitrification requires that nitrogen first be converted to nitrate, which typically occurs in an aerobic treatment process, such as a trickling filter or suspended-growth process. The nitrified water is then exposed to an environment without free oxygen. Organisms in this anoxic system use the nitrate and release nitrogen gas or nitrogen oxides. Sulfate also can be used, resulting in hydrogen sulfide. Efficient denitrification processes need a carbon source that is readily biodegradable.

D.3 DISINFECTION SYSTEMS

Waterborne pathogens found in the United States include some bacteria, protozoans, and viruses. The process of disinfection destroys pathogenic and other microorganisms in wastewater and can be used to reduce the possibility of pathogenic organisms entering the environment.

Currently, the effectiveness of disinfection is measured by the use of indicator bacteria. Indicator bacteria are selected groups of microorganisms that indicate the possible presence of disease-causing pathogens. It is difficult to detect all types of pathogenic organisms in water because of the wide array of microbes that occur in the natural environment. As a solution, indicator organisms that are easy to detect are typically used.

A number of methods are available to disinfect wastewater. The most common types of onsite disinfection units use chlorine tablets, ultraviolet radiation, and ozonation. These approaches and their effectiveness are summarized below.

D.3.1 CHLORINATION

Chlorine is a powerful oxidizing agent and has been used as an effective disinfectant in water and wastewater treatment for a century. For small onsite wastewater treatment systems, the most common type of disinfection equipment is the tablet chlorinator because it does not require electricity, is easy to operate and maintain, and is relatively inexpensive. The tablet chlorinator uses the solid form of chlorine, calcium hypochlorite, to achieve disinfection. Simple liquid sodium hypochlorite (bleach) aspirator or suction feeders are also available. These systems are more reliable than tablet chlorinators, but they require more oversight and are therefore less commonly used.

In the tablet chlorination system, a solid tablet of calcium hypochlorite is partially submerged in the wastewater flow. As the water to be treated flows through the chlorination device, the chlorine tablet slowly dissolves and releases chlorine into the water. As the chorine tablet dissolves, another chlorine tablet slides down into the wastewater flow.

Chlorinated water may inhibit the performance of subsequent soil treatment systems. In some cases, chlorination has been used to inhibit biological growth in trickling filter systems. In areas where water is distributed for irrigation, chlorine is used to prevent the spread of disease through wastewater.

There have been few field studies of tablet chlorinators, but those that exist for post-sand filter applications show fecal coliform reductions of 2–3 logs per 100 milliliters (ml). Another field study of tablet chlorinators following biological treatment units exceeded a standard of 200 logs of fecal coliform per 100 ml 93% of the time (EPA 2002). No chlorine residual was present in 68% of the samples. Performance problems with tablet chlorinators have been associated with TSS accumulation in the chlorinator, tablet caking, failure of the tablet to drop into the sleeve, and failure to maintain the tablet supply. Sodium hypochlorite liquid feed systems can provide consistent disinfection of sand filter effluents (and biological system effluents) if the systems are adequately managed (EPA 2002).

D.3.2 ULTRAVIOLET RADIATION

UV light is an effective disinfectant for water and wastewater. The germicidal properties of UV irradiation have been recognized for many years, and the technology is widely available and well characterized. UV is germicidal in the wavelength range of 250–270 nanometers. The effectiveness of UV irradiation highly depends on the quality of the wastewater to be treated. Wastewater particles have the ability to absorb UV radiation, yet the only UV radiation effective in destroying microorganisms is that which reaches the cells. Lower levels of turbidity and suspended solids in the wastewater therefore lead to greater microorganism inactivation and result in improved disinfection.

A common configuration of a UV disinfection system is composed of one or more lamps that are encased in a quartz sleeve and submerged in a tubular reactor. Water to be treated enters one end of the reactor and is exposed to the UV radiation. After sufficient exposure, the water exits the system and is discharged. In some applications, the water is recirculated through the UV system to improve overall treatment.

Data on UV disinfection for onsite systems are limited. Typical units treating sand filter effluents have been shown to remove more than 3 logs of fecal coliform and more than 4 logs of poliovirus (EPA 2002).

D.3.3 OZONATION

Ozone is a strong oxidant that has been used for the disinfection of water and wastewater. Because ozone is not chemically stable, it must be generated onsite near the point of use, making the system more complex than tablet chlorinators. It has been used in combination with other compounds for advanced oxidation treatment of wastewater. Ozone is used primarily for medium and large treatment facilities; however, ozone disinfection may become feasible for small systems in the future.

The ozonation process comprises several steps: the generation of ozone gas, the transfer of ozone gas into the water to be treated, and the mixing and contact between ozone and the water to obtain treatment results. Process performance depends on factors such as the ozone concentration and contact time, the characteristics of the water to be treated, and the characteristics of the organisms to be destroyed. Under normal operating conditions, for high-quality effluents, ozone can be an effective disinfection method.